WHAT IS CLAIMED IS:

- 1. A method for manufacturing a semiconductor device,
- 2 comprising a dual-stage deposition step comprising:
- 3 a first stage for introducing a material gas containing
- 4 desired metal into a reaction chamber in which a semiconductor
- 5 substrate on a surface of which a metal film is formed in part
- 6 or in entirety is placed to thus form an oxide film made of said
- 7 specified metal by a vapor-phase growth method and the following
- 8 second stage for removing from said reaction chamber said material
- 9 gas introduced into said reaction chamber at said first stage and
- 10 a byproduct produced at said first stage, and
- wherein said metal oxide film as an oxide of said specified
- 12 metal is formed on said semiconductor substrate, by repeating said
- 13 dual-stage deposition step two or more times.
 - 1 2. The method according to claim 1, wherein said
 - 2 semiconductor substrate has a cylindrical trench on a surface
 - 3 thereof in such a configuration that said metal film is formed
 - 4 on a bottom and an inner side wall of said cylindrical trench.
 - 1 3. The method according to claim 1, wherein said material
 - 2 gas and said byproduct produced at said first stage are removed
 - 3 by introducing a gas different from said material gas at said first
 - 4 stage into said reaction chamber at said second stage.
 - 1 4. The method according to claim 1, wherein said material
 - 2 gas and said byproduct produced at said first stage are removed
 - 3 by depressurizing said reaction chamber at said second stage.

- 5. The method according to claim 4, wherein after having
- 2 performed said depressurizing at said second stage and before said
- 3 first stages starts in a next dual-stage deposition step, a gas
- 4 different from said material gas is introduced into said reaction
- 5 chamber to thus recover a gas pressure before performing said
- 6 depressurizing in said reaction chamber.
- 1 6. The method according to claim 1, wherein said metal
- 2 oxide film having a finally required film thickness is formed by
- 3 repeating said steps a plurality of number of times.
- 7. The method according to claim 1, wherein after said
- 2 steps are repeated a plurality of number of times, said material
- 3 gas is introduced continuously for a time longer than that
- 4 required for said first stage, to form said metal oxide film having
- 5 the finally required film thickness.
- 1 8. The method according to claim 1, wherein an oxidizing
- 2 gas is introduced at said first stage.
- 9. The method according to claim 8, wherein introduction
- 2 of said oxidizing gas is started from a second-time said steps.
- 1 10. The method according to claim 1, wherein said second
- 2 stage comprises a process for introducing an oxidizing gas and
- 3 a process for introducing said material gas and a gas different
- 4 from said oxidizing gas.
- 1 11. The method according to claim 3, wherein said gas

- 2 different from said material gas is an inactive gas.
- 1 12. The method according to claim 11, wherein said inactive
- 2 gas is a nitrogen gas.
- 1 13. The method according to claim 1, wherein said metal
- 2 film is made of metal having a catalytic action.
- 1 14. The method according to claim 1, wherein said
- 2 vapor-phase growth method is a chemical vapor deposition method
- 3 or a physical vapor deposition method.
- 1 15. The method according to claim 1, wherein said metal
- 2 oxide film as said oxide of said specified metal is made of at
- 3 least one selected from the group consisting essentially of
- 4 tantalum, hafnium, zirconium, and niobium.
- 1 16. The method according to claim 15, wherein tantalum
- 2 penta-ethoxide is used as said material gas.
- 1 17. The method according to claim 8, wherein as said
- 2 oxidizing gas, a gas containing oxygen, ozone, water, nitrogen
- 3 oxide, or oxygen radical is used.
- 1 18. The method according to claim 13, wherein as said metal
- 2 having a catalytic action, ruthenium or platinum is used.
- 1 19. A method for manufacturing a semiconductor device
- 2 having a capacitor, comprising:

- 3 a dual-stage deposition step comprising:
- 4 a first stage for introducing a material gas containing
- 5 desired metal into a reaction chamber in which a semiconductor
- 6 substrate on a surface of which a metal film is formed in part
- 7 or in entirety is placed to thus form an oxide film made of said
- 8 desired metal by a vapor-phase growth method and the following
- 9 second stage for removing from said reaction chamber said material
- 10 gas introduced into said reaction chamber at said first stage and
- 11 a byproduct produced at said first stage, and
- wherein said metal oxide film as an oxide of said specified
- 13 metal is formed on said semiconductor substrate, by repeating said
- 14 dual-stage deposition step two or more times, thereby forming a
- 15 capacitive insulating film to make up said capacitor; and
- forming an upper electrode to make up said capacitor on said
- 17 capacitive insulating film.
- 1 20. The method according to claim 19, wherein said
- 2 semiconductor substrate has a cylindrical trench on a surface
- 3 thereof in such a configuration that said metal film is formed
- 4 on a bottom and an inner side wall of said cylindrical trench.
- 1 21. The method according to claim 19, wherein said material
- 2 gas and said byproduct produced at said first stage are removed
- 3 by introducing a gas different from said material gas at said first
- 4 stage into said reaction chamber at said second stage.
- 1 22. The method according to claim 19, wherein said material
- 2 gas and said byproduct produced at said first stage are removed
- 3 by depressurizing said reaction chamber at said second stage.

- 1 23. The method according to claim 22, wherein after having
- 2 performed said depressurizing at said second stage and before said
- 3 first stages starts in a next dual-stage deposition step, a gas
- 4 different from said material gas is introduced into said reaction
- 5 chamber to thus recover a gas pressure before performing said
- 6 depressurizing in said reaction chamber.
- 1 24. The method according to claim 19, wherein said metal
- 2 oxide film having a finally required film thickness is formed by
- 3 repeating said steps a plurality of number of times.
- 1 25. The method according to claim 19, wherein after said
- 2 steps are repeated a plurality of number of times, said material
- 3 gas is introduced continuously for a time longer than that
- 4 required for said first stage, to form said metal oxide film having
- 5 the finally required film thickness.
- 1 26. The method according to claim 19, wherein an oxidizing
- 2 gas is introduced at said first stage.
- 1 27. The method according to claim 26, wherein introduction
- 2 of said oxidizing gas is started from a second-time said steps.
- 1 28. The method according to claim 19, wherein said second
- 2 stage comprises a process for introducing an oxidizing gas and
- 3 a process for introducing said material gas and a gas different
- 4 from said oxidizing gas.
- 1 29. The method according to claim 21, wherein said gas

- 2 different from said material gas is an inactive gas.
- 1 30. The method according to claim 29, wherein said inactive
- 2 gas is a nitrogen gas.
- 1 31. The method according to claim 19, wherein said metal
- 2 film is made of metal having a catalytic action.
- 1 32. The method according to claim 19, wherein said
- 2 vapor-phase growth method is a chemical vapor deposition method
- 3 or a physical vapor deposition method.
- 1 33. The method according to claim 19, wherein said metal
- 2 oxide film as said oxide of said specified metal is made of at
- 3 least one selected from the group consisting essentially of
- 4 tantalum, hafnium, zirconium, and niobium.
- 1 34. The method according to claim 33, wherein tantalum
- 2 penta-ethoxide is used as said material gas.
- 1 35. The method according to claim 26, wherein as said
- 2 oxidizing gas, a gas containing oxygen, ozone, water, nitrogen
- 3 oxide, or oxygen radical is used.
- 1 36. The method according to claim 31, wherein as said metal
- 2 having a catalytic action, ruthenium or platinum is used.
- 1 37. A method for manufacturing a semiconductor device,
- 2 performing a first stage for introducing a material gas containing

3 desired metal into a reaction chamber in which a semiconductor substrate on a right side of which a metal film is formed is placed 4 to thus form an oxide film made of said desired metal by a 5 6 vapor-phase growth method and the following second stage for 7 removing from said reaction chamber said material gas introduced 8 into said reaction chamber at said first stage and a byproduct produced at said first stage and then introducing said material 9 10 gas continuously for a lapse of time longer than said first stage, 11 thereby forming an oxide film made of said metal having a finally 12 required film thickness.